Knowledge Driven Optimization and Finite Element Analysis of Aircraft Structures.

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R. Curran, G. Gomis, A. Murphy, S. Castagne, P. Morenton and A. Rothwell

Abstract

The paper presents a knowledge driven methodology for the global integration of aircraft structural design based on structural analysis and manufacturing cost optimization relative to weight. The initial design of a fuselage structure is generated from a numerical solution considering the weight and manufacturing cost of the structure relative to Direct Operating Cost. That baseline configuration is then used as the geometrical definition that is analyzed at a more detailed level using the Finite Element Analysis (FEA) method. Fuselage panels are made of a skin-stringer assembly that locally buckles under normal flight loads. The finite element method has the potential to give a representation of the buckled shape as well as a value for the local critical buckling load of any mode investigated. The paper investigates the potential for adopting a suit of integration tools in the Dassault V5 platform in order to implement an iterative design, structural analysis and optimization process for fuselage panels. It is convenient to use the platform in order to obtain structural data that would then be reused in the optimization workbench built within the platform. Results from the fuselage finite element model are compared to both experimental data and theoretical predictions before being linked to the optimization tool. The fuselage panel is then optimized for minimum weight while still resisting an applied compressive load without buckling. The optimization process parameters are analyzed using statistical methods. It is shown that a fully integrated way of designing and optimizing fuselage panels is achievable. The paper therefore presents a methodology to implement and run an integrated design optimization of a structure loaded in compression. Consequently, the tool facilitates a concurrent engineering approach to the product development phase, both compressing lead time and improving the sharing of relevant multidisciplinary information, which traditionally tends to be carried out in a more serial manner.